ARAC WG Report

Report from the PowerPlant Installation Harmonization Working Group

Rule Section: FAR 25.904/JAR 25X20(c) and FAR/JAR 25 Appendix I

What is the underlying safety issue addressed by the FAR/JAR?: This appendix specifies additional requirements if an applicant elects to install an engine control system that automatically increases thrust or power on the operating engine(s) if an engine fails during takeoff. With such a system installed, takeoffs would normally be made with thrust or power set at less than the maximum takeoff thrust or power. If an engine fails, the system automatically increases thrust on the operating engine(s) to the maximum takeoff thrust or power.

Compliance with the additional requirements specified in the appendix for airplane performance, system reliability, initial thrust setting, powerplant controls, and powerplant instruments allows the takeoff power or thrust obtained after operation of the engine control system to increase power or thrust to be used to meet the part 25 one-engine-inoperative airplane performance requirements. By specifying these additional requirements, and recognizing that the use of reduced takeoff thrust reduces the probability of an engine failure, this appendix ensures that incorporation of such a system provides an equivalent level of safety to that intended by the basic part 25 requirements.

What are the current FAR and JAR standards?: see Appendix 3 & Appendix 4, respectively.

What are the differences in the standards and what do these differences result in?: The differences between the two standards and the effects of differences are summarized as follows:

1. In the FAR, the initial power setting used for takeoff may not be less than 90 percent of the maximum takeoff thrust or power approved for the airplane under the existing ambient conditions. The JAR does not limit the initial power setting, but limits the thrust that can be used to show compliance with the JAR-25 airplane performance requirements to no more than 111 percent of the initial power setting. The FAR standard is more stringent because it precludes taking credit for any performance benefit associated with the automatic thrust increase when the initial takeoff power setting is less than 90 percent of the maximum takeoff thrust. At an initial power setting of 90 percent of the maximum takeoff thrust, the two standards are equivalent in terms of the resulting performance credit granted, but the JAR allows credit for further reductions in the initial power setting while the FAR does not.

   The effect of this difference is that the takeoff weight of an airplane certificated to the FAR standards may be restricted to a lesser value relative to that available to an

airplane certificated to the JAR standards when the initial thrust or power setting is less than 90 percent of the maximum takeoff thrust. The operator of an airplane certificated to the FAR standards may therefore realize a potential revenue loss due to a loss of payload-carrying capability compared to an operator of an airplane certificated to the JAR standards.

2. The JAR requires that inadvertent operation of the automatic system be either of a remote probability or have no more than a minor effect on safety. The FAR does not explicitly address inadvertent operation. The JAR standard is more stringent and requires a more reliable system design.

3. For airplanes equipped with limiters that automatically prevent engine operating limits from being exceeded under existing ambient conditions, a means other than normal use of the power or thrust levers may be used to manually increase power or thrust to the maximum power or thrust. The FAR is more stringent in that it requires that other means to be located on or forward of the thrust or power levers and that it meet the requirements of § 25.177(a), (b), and (c). The JAR only requires the other means to be in an accessible position on or close to the thrust or power levers. This rule difference can lead to differences in the placement of the means used to manually increase thrust or power between airplanes certificated under the different standards. This potential feature is no longer considered required and has been removed. The allowance was introduced to accommodate existing designs at the time the original rule was introduced.

4. The FAR uses the term "Automatic Takeoff Thrust Control System (ATTCS)" for such a system, while the JAA uses the term "Automatic Reserve Performance (ARP) System." This difference is in nomenclature only and does not affect the requirements or stringency of the standards.

5. Another editorial difference is that the FAR combines the performance and system reliability in one section, § I25.3, while the JAR separates these items into two paragraphs, JAR I25.3 and I25.4. As a result, the numbering of the succeeding paragraphs differ between the FAR and the JAR. Various other editorial differences exist as well, but they do not affect the application of the standards.

What, if any, are the differences in the means of compliance?: Except for the means of compliance associated with the differences in the standards, the means of compliance are the same.

What is the proposed action?: The proposed action is to harmonize the standards by using the least costly means of ensuring that the underlying safety issue is addressed. Also, the harmonized standard would be updated to include appropriate safety standards for additional capabilities that have been incorporated into more recent system designs for which the current FAR or JAR standards do not contain adequate or appropriate safety

standards. In accordance with § 21.16, the FAA has issued special conditions for several airplane types to provide appropriate safety standards for these additional capabilities. These additional capabilities include the use of an engine control system to increase power when an engine fails during or prior to a go-around. The additional standards proposed here are based on those special conditions as well as similar special conditions issued by the JAA.

The changes addressed in this proposal are:

- Use of the term **Automatic Performance Reserve (APR)** as the harmonized name for a system that automatically resets power or thrust on the operating engine(s) when an engine fails during a takeoff or go-around. A majority of airplane and engine manufacturers has been using this term rather than the terms "Automatic Takeoff Thrust Control System (ATTCS)" or "Automatic Reserve Performance (ARP) System" used in the current FAA and JAA standards, respectively. In the proposed harmonized standard, "Automatic Performance Reserve (APR)" would replace "Automatic Takeoff Thrust Control System (ATTCS)" throughout § 25.904 and Appendix I to part 25, and replaces "Automatic Reserve Performance (ARP) System" throughout JAR 25X20(c) and Appendix I to JAR-25. This change would not affect the level of safety intended by the standards.

- **Harmonization of editorial differences.** As an editorial change, the current § I25.3, "Performance and System Reliability Requirements," would be split into two sections: § I25.3 "Performance Requirements," and § I25.4 "Reliability Requirements." The remaining current §§ I25.4 through I25.6 would be renumbered as §§ I25.5 through I25.7. For the most part, the harmonized standard would be based editorially on the current FAR standard. Miscellaneous editorial changes are proposed to improve clarity.

- **Use of APR for go-around.** As noted above, special conditions have been issued for several airplane types (e.g., BAe Systems Jetstream 41, CASA C-295, Dassault Falcon 2000, DeHavilland DHC8-400, Bombardier CRJ 700) to approve the use of an APR system for go-around. Use of such a system for go-around extends engine life and reduces the probability of an engine failure by allowing a lower power or thrust level to be set when conducting a go-around with all engines operating. If an engine fails during the go-around, the APR system will automatically increase power on the operating engine(s) to the go-around power or thrust setting without any action by the pilot. Installation of an APR system for go-around allows the use of the go-around power or thrust setting to be used to show compliance with the one-engine-inoperative approach climb requirements of § 25.121(d) even though a reduced power setting is used for normal operations (i.e., with all engines operating).

  Although APR for go-around is very similar to APR for takeoff, there are three important differences that cause the requirements applicable to takeoff, which are the standards currently included in appendix I, inadequate to address the safety issues

associated with a go-around. First, a go-around may be initiated with an engine previously shut down or otherwise made inoperative, in addition to the case where the engine failure occurs during the go-around. Second, the I25.5(b)(3) requirement for a means for the flightcrew to verify before takeoff that the system is in a condition to operate does not ensure adequate reliability or flightcrew awareness regarding the operability of the system. Third, as noted in the preamble to Amendment 25-62 to 14 CFR part 25, which is the amendment that added Appendix I to part 25, flightcrew workload issues precluded expanding the scope of the standards to include phases of flight other than takeoff. The preamble specifically referred to go-around, where it was stated:

> "In regard to ATTCS credit for approach climb and go-around maneuvers, current regulations preclude a higher power for the approach climb (§ 25.121(d)) than for the landing climb (§ 25.119). The workload required for the flightcrew to monitor and select from multiple in-flight power settings in the event of an engine failure during a critical point in the approach, landing, or go-around operations is excessive. Therefore, the FAA does not agree that the scope of the amendment should be changed to include the use of ATTCS for anything except the takeoff phase."

To address these issues, the following changes to appendix I are proposed:

The critical time interval (CTI), during which it must be extremely improbable for the concurrent existence of an engine and APR system failure, would be redefined for the go-around case. The CTI for the go-around case would ensure that it is extremely improbable to violate a flight path based on the §/JAR 25.121(d) one-engine-inoperative approach climb gradient requirement. This critical time interval would take into account that the engine may be inoperative before initiating the go-around, or it may fail during the go-around.

The working group considered various methods for defining the CTI for go-around, including the methods used in the previously mentioned FAA special conditions as well as similar certification requirements for these systems that were established by the JAA and Transport Canada. In examining the different methods and their effects on APR system design, the working group found that a rigorous CTI definition is unnecessary. The CTI, as only one of the criteria used to establish the reliability requirements for the system, is not limiting for current or envisaged future designs. Another reliability criterion contained in the proposed harmonized standard, the consideration of the elapsed time since verification that the system is in a condition to operate, is always more critical than the CTI. For some APR system elements, verification of operability can only be performed prior to commencing the flight, so the elapsed time since verification includes the entire duration of the flight. The short duration of the CTI has a very minor effect on the overall time at risk and therefore on the calculated APR system reliability.

Because the CTI for go-around has little or no effect on the design of the APR system, it could be argued that there is no need to require it to even be considered. However, to retain consistency with the takeoff APR requirements, provide visibility to the issue, and to cover potential future designs for which the CTI could be a critical factor, the working group is not proposing to exclude a CTI value for go-around. Instead, the use of a single, conservative CTI value of 120 seconds is proposed. This value is more stringent than would be obtained through any of the more rigorous methods that have been used, but greatly simplifies the task of showing compliance. For comparison purposes, the CTI for the BAe Systems Jetstream 41 & Bombardier CRJ700 airplanes were determined to be 26 & 35 seconds respectively using the complex method specified in the FAA special conditions.

To address potential designs where the use of such a conservative CTI value would be unduly penalizing, the proposed standard would allow the use of a rational analysis to justify using a shorter time interval. An acceptable method for conducting a rational analysis would be provided in a proposed AC/ACJ (attached), and would be based on the method given in the FAA special conditions. Also, it should be pointed out in the preamble to the proposed regulatory amendment that since the basis of the proposed CTI value is that 120 seconds is conservative and not limiting, if it turns out that this value is not conservative and the rationally derived CTI would be limiting, then a rationally derived CTI must be used.

(1) This definition of the critical time interval for go-around would be added as a new §/JAR I25.2(b)(2). The current §/JAR 25.5(b) would be reformatted such that the definition of the critical time interval for takeoff would become §/JAR I25.2(b)(1).

(2) To address the issue of the verification of system operability, a new §/JAR I25.4(d) would be added to require the safety analysis to include consideration, as applicable, of an APR system failure occurring after the time at which the flight crew last verifies that the APR system is in a condition to operate until the end of the critical time interval.

(3) To address the crew workload issues, a new §/JAR 25.5(b) would be added to require, for approval of an APR system for go-around, the same thrust or power setting procedure to be used for go-around initiated with either all engines operating or with one engine inoperative. This requirement is intended to ensure the same flightcrew action is used to set go-around power or thrust regardless of whether or not an engine is inoperative. As stated in the preamble to Amendment 25-62, the flightcrew cannot be expected to select, set, and monitor from multiple power settings in the event of an engine failure during a critical point in the approach, landing, or go-around.

In addition to the change noted above, the following rule sections (as renumbered under the proposal to reformat the FAR to harmonize with the JAR) would be amended to reference go-around in order to make the requirements applicable to go-around if that capability is sought by the applicant: § 25.904 (JAR 25X20(c) would be removed), §/JAR I25.1(a), §/JAR 25.2(a), §/JAR 25.3(a), §/JAR 25.3(b), §/JAR I25.5(a), I25.5(b), §/JAR 25.6(b)(1), §/JAR 25.6(b)(2), and §/JAR 25.7(b).

- **Thrust or power setting**. The proposed harmonized standard would replace the FAR limitation that the initial thrust or power setting must not be less than 90 percent of the thrust or power set by the APR system after an engine failure with the JAR requirement that the thrust used to show compliance with the applicable one-engine-inoperative climb requirements not be greater than 111 percent of the thrust obtained at the initial thrust or power setting. Both standards are intended to ensure an adequate climb capability with all engines operating and to limit the degradation of performance if the critical engine fails and the APR system fails to apply maximum takeoff thrust or power on the operating engine(s).

  The FAR limitation was also driven by pilot workload concerns, similar to the workload concerns with extending APR capability to cover the go-around phase of flight. The preamble to Amendment 25-62 states:

  > "The FAA has not restricted ATTCS operations where airplane performance is based on an approved "derate" rating which has corresponding engine and airplane limits approved for use under all weight, altitude, and temperature (WAT) conditions. However, the FAA has not allowed the reduced thrust (assumed temperature or weight decrement method) operations to be combined with ATTCS because the resulting flight procedures would increase the pilot workload by creating an infinite number of initial all-engine and engine-failed thrust settings. The increased workload could lead to performance computation error, and create confusion for the crews' workload during a critical high workload engine failure situation. Operationally, noise abatement procedures have already created another set of thrust settings which must be monitored and set. The combination would substantially increase exposure to performance limiting condition, and this clearly would not be equivalent to current regulations, which are based on a single thrust setting for takeoff."

  Since the time that was written, the FAA has allowed reduced thrust operations with the APR system operating, but has not allowed the thrust or power increase provided by the APR system after an engine failure to be used to show compliance with the airplane performance requirements. The proposed harmonized standard would allow performance credit for a thrust or power increase limited to 111 percent of the initial thrust or power set at the beginning of the takeoff or go-around. A thrust or power

increase of 111 percent is equivalent to the increase achieved in going from an initial setting of 90 percent to 100 percent of the thrust or power set by the APR system after an engine failure.

The pilot workload issue would be the same for an initial thrust or power setting of 89 percent of the maximum takeoff thrust or power as it would for an initial thrust or power setting of 90 percent. During the critical time interval it must be extremely improbable for a combined engine and APR system failure. This requirement provides sufficient time for the flightcrew to determine if additional thrust or power is needed in the event of a combined engine and APR system failure. Current § I25.5(b)(2), which would be redesignated § I25.6(b)(1) already requires that the system allow manual increase or decrease of the thrust or power up to the maximum takeoff thrust or power. There is no need for the flightcrew to determine and set the specific one-engine-inoperative thrust or power setting that would normally be set by a functioning APR system as long as the appropriate thrust or power setting limits are displayed on the relevant cockpit instrument displays.

- **Inadvertent operation**. The proposed harmonized standard would include the additional JAA requirement regarding the potential for: inadvertent operation. The current JAR I25.4(c) would be adopted as harmonized §/JAR I25.4(c).

- **Means to deactivate**. In recognition that modern FADEC controls have the APR system as an integral part of the control and hence abnormalities or apparent inadvertent operation indicates a basic control function fault or failure, a dedicated means to deactivate the APR system may not be required. Reducing power or thrust to idle or shutting down the engine may be the appropriate action. In the proposed harmonized standard, current § I25.5(b)(4) would be revised to indicate that a means to deactivate the automatic function need not be provided if it can be shown that such a means is unnecessary for safety. Typically, this would involve substantiation the APR system without a switch can comply with §§/JAR 25.1301 and 25.1309 and that a deactivation means will never be needed in order to maintain the same level of safety as would be present if a switch were available.

What should the harmonized standard be?: See below

Proposed text of harmonized standard: See Appendix 1.

How does this proposed standard address the underlying safety issue?: It continues to ensure that incorporation of such a system provides a level of safety intended by the basic Part 25 requirements, adopting the appropriate existing FAR/JAR standards and adding safety standards from applicable special conditions) issued for capabilities added since the standards were adopted.

Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety?: The proposed standard maintains the level of safety by incorporating existing accepted regulatory requirements and adds the JAR requirement relative to inadvertent operation of the system.

Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety?: It maintains the current level of safety since industry practice is to comply with both the FAR and the JAR, including any applicable special conditions.

What other options have been considered and why were they not selected?: The harmonization of the most stringent of the FAR / JAR material was considered for the 'fast track' process. This option was not pursued because it did not address the additional capability of APR for go-around. The majority of recently certificated aircraft with an APR system provide this capability and have required special conditions for airworthiness approval.

The group also considered addressing APR credit beyond the take-off / go-around power set regime (e.g., Climb power to Maximum Continuous power).
The group decided that this change could not be made within the schedule defined for the Fast Track Harmonization Program.

Who would be affected by the proposed change?: Manufacturers and operators of transport category airplanes and manufacturers of the engines and engine power control systems for those airplanes that automatically reset thrust or power on the operating engine(s) in the event of the failure of an engine could be affected by the proposed change.

To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble?: None.

Is existing FAA advisory material adequate? (If not, what advisory material should be adopted?): Existing advisory material in Advisory Circulars 25-13 and 25-7A would need to be revised to reflect the changes in the standards. The proposed revisions are included as Appendix 2 to this report. An AC to assist in the interpretation of the criteria contained within the proposed rule, particularly a rational analysis method to define the CTI for go-around, would be beneficial but not a condition to publishing the new / revised standard.

How does the proposed standard compare to the current ICAO standards?: The proposed standards are consistent with, but more detailed than the ICAO standards.

Does the proposed standard affect other harmonization working groups?: Yes, FTHWG.

What is the cost impact of complying with the proposed standard?:
The proposed standards offer more flexibility and reflect currently accepted practice in compliance with the current standards as augmented by the issuance of special conditions. There should be a reduction in certification cost.

Does the working group want to review the draft NPRM prior to publication in the Federal Register?: Yes.

In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain: Yes, the "Fast Track" process is appropriate for this project. The project is neither too complex nor too controversial to use the "Fast Track" process. However, due to the change in categorization of this project from category 1 (envelope) to category 3 (harmonize), additional time is needed to complete this task and coordinate a recommendation from the Power Plant Installation and Flight Test Harmonization Working Groups.

APPENDIX 1 Proposed Rule Change

§/JAR 25.904 : **Automatic performance reserve (APR) system.**
Each applicant seeking approval for an airplane equipped with an engine control system that automatically increases the power or thrust on the operating engine(s) either when an engine fails during a takeoff/take-off or during a go-around when an engine becomes inoperative either before or after the go-around is initiated must comply with the additional requirements of Appendix I of this part.

§/JAR 25 Appendix I: **Automatic Performance Reserve (APR) System**

I 25.1 *General.*

(a) This Appendix specifies additional requirements for airplanes/aeroplanes equipped with an engine control system that automatically increases thrust or power on the operating engine(s) either when an engine fails during a takeoff/take-off or during a go-around when an engine becomes inoperative either before or after the go-around is initiated, or both.

(b) With the APR system and associated systems functioning normally as designed, all applicable requirements of part 25/JAR-25, except as provided in this Appendix, must be met without requiring any action by the crew to increase thrust or power.

I 25.2 *Definitions.*

(a) Automatic Performance Reserve (APR) System. An APR system is defined as a system that automatically increases thrust or power on the operating engines(s) either when an engine fails during a takeoff/take-off or during a go-around when an engine becomes inoperative either before or after the go-around is initiated. For the purpose of showing compliance with the requirements in this appendix/Appendix, the APR system comprises all elements of equipment necessary for the control and performance of each intended function, including the engine control system and all devices, both mechanical and electrical, that sense engine failure, transmit signals, actuate fuel controls or power levers of the operating engines(s) to achieve scheduled thrust or power changes, and furnish cockpit information on system operation.

(b) Critical Time Interval. The critical time interval for an APR system that automatically increases thrust or power on the operating engine(s) after an engine fails is defined as follows:

(1) For takeoff, the critical time interval is between one second before reaching V_1, and the point on the takeoff/take-off flight path with all engines operating where, assuming a simultaneous engine and APR system failure, the resulting flight path thereafter intersects the flight path determined in accordance with §/JAR 25.115,

at not less than 400 feet above the takeoff/take-off surface. This time interval is shown in Figure 1.

(2) For go-around, the critical time interval is defined as 120 seconds. A shorter time interval may be used if justified by a rational analysis.

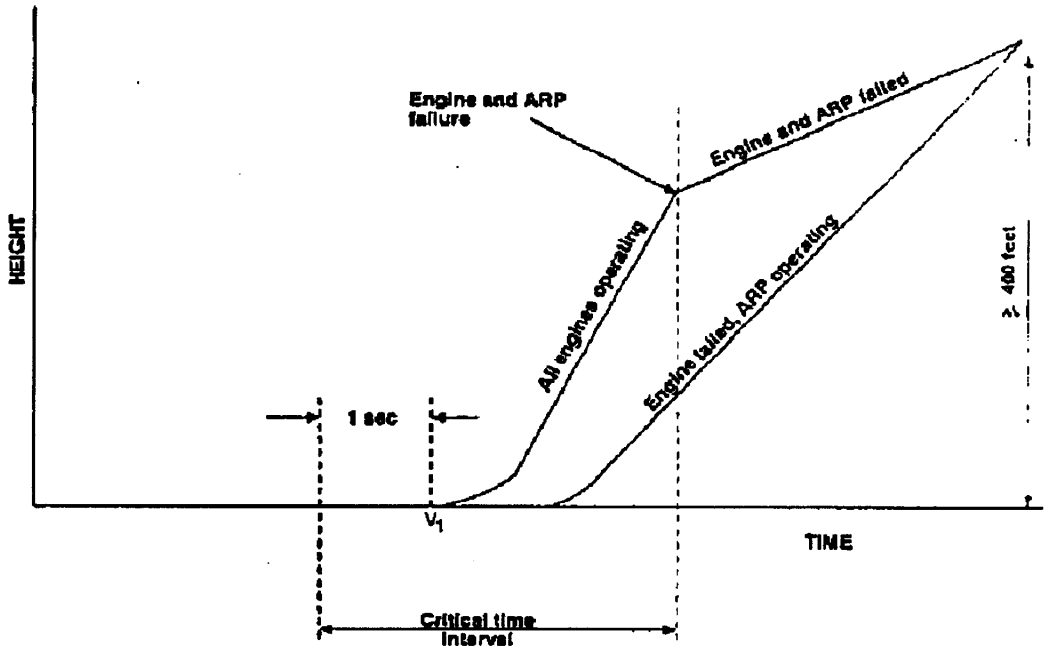

Figure A

I 25.3 *Performance Requirements.*

(a) All applicable performance requirements of part 25/JAR-25 must be met after failure of the critical engine at the most critical point during a takeoff or go-around, as applicable, with the APR system functioning.

(b) The propulsive thrust obtained from each operating engine after failure of the critical engine during take-off, or during a go-around, as applicable, used to show compliance with the one-engine-inoperative climb requirements of §/JAR 25.121(a), (b), and (d), as applicable, may not be greater than the lesser of–

(1) The actual propulsive thrust resulting from the initial setting of power or thrust controls with the APR system functioning; or

(2) 111 percent of the propulsive thrust resulting from the initial setting of power or thrust controls with the APR system failing to reset thrust or power and without any action by the crew to reset thrust or power.

I 25.4 *Reliability Requirements.*

(a) An APR system failure or a combination of failures in the APR system during the critical time interval:
  (1) That prevents the automatic insertion of the intended takeoff or go-around thrust or power, as applicable, must be improbable.
  (2) That results in a significant loss or reduction in thrust or power must be improbable.
(b) The concurrent existence of theAPR system failures regulated in section (a) above and an engine failure during the critical time interval must be extremely improbable.
(c) The inadvertent operation of the APR system must be remote or to have no more than a minor effect.
(d) The safety analysis must include consideration, as applicable, of an APR system failure occurring after the time at which the flight crew last verifies that the APR system is in a condition to operate until the end of the critical time interval.

I 25.5 *Thrust or Power Setting.*

(a) The initial thrust or power setting on each engine at the beginning of the takeoff roll or go-around, as applicable, may not be less than either of the following:

  (1) That required to permit normal operation of all safety-related systems and equipment dependent upon engine thrust or power lever position; or
  (2) That shown to comply with the applicable airplane controllability and engine operating characteristics requirements if thrust or power is increased from the initial takeoff thrust or power to the maximum available takeoff thrust or power at any point in the takeoff, or the initial thrust or power used for go-around to the maximum available go-around thrust or power at any point in the go-around, as applicable.

(b) For approval of an APR system for go-around, the thrust or power setting procedure must be the same for go-arounds initiated with all engines operating as for go-arounds initiated with one engine inoperative.

I 25.6 *Powerplant Controls.*

APPENDIX 1 Proposed Rule Change

(a) In addition to the requirements of §/JAR 25.1141, no single failure or malfunction, or probable combination thereof, of the APR system, including associated systems, may cause the failure of any powerplant function necessary for safety.
(b) The APR system must be designed to:

(1) Permit manual decrease or increase in thrust or power up to the maximum available takeoff/go-around thrust or power through the use of the normal thrust or power levers.;
(2) Provide a means to verify to the flightcrew before takeoff and before beginning an approach for landing, as applicable, that the APR system is in a condition to operate; and
(3) Provide a means for the flightcrew to deactivate the automatic function, unless it can be shown that such a means is unnecessary for safety. This means must be designed to prevent inadvertent deactivation.

I 25.7 *Powerplant Instruments*

In addition to the requirements of §/JAR 25.1305:
(a) A means must be provided to indicate when the APR system is in the armed or ready condition; and
(b) If the inherent flight characteristics of the airplane do not provide adequate warning that an engine has failed, a warning system that is independent of the APR system must be provided to give the pilot a clear warning of an engine failure during the takeoff or go-around, as applicable.
(c) Engine indications must provide sufficient information during the takeoff or go-around, as applicable, to show whether or not the engine is capable of achieving the maximum available thrust or power without exceeding engine limits.

APPENDIX 3 Current FAR Text

25.904 Automatic Takeoff Thrust Control System

Each applicant seeking approval for installation of an engine power control system that automatically resets the power or thrust on the operating engine(s) when any engine fails during the takeoff must comply with the requirements of Appendix I of this part.

APPENDIX I

I 25.1 *General*

(a) This appendix specifies additional requirements for installation of an engine power control system that automatically resets thrust or power on operating engine(s) in the event of any one engine failure during takeoff.

(b) With the ATTCS and associated systems functioning normally as designed, all applicable requirements of Part 25, except as provided in this appendix, must be met without requiring any action by the crew to increase thrust or power.

I 25.2 *Definitions*

(a) *Automatic Takeoff Thrust Control System (ATTCS).* An ATTCS is defined as the entire automatic system used on takeoff, including all devices, both mechanical and electrical, that sense engine failure, transmit signals, actuate fuel controls or power levers or increase engine power by other means on operating engines to achieve scheduled thrust or power increases, and furnish cockpit information on system operation.

(b) *Critical Time Interval.* When conducting an ATTCS takeoff, the critical time interval is between V_1 minus 1 second and a point on the minimum performance, all-engine flight path where, assuming a simultaneous occurrence of an engine and ATTCS failure, the resulting minimum flight path thereafter intersects the Part 25 required actual flight path at no less than 400 feet above the takeoff surface. This time interval is shown in the following illustration:

[Illustration]

I 25.3 *Performance and System Reliability Requirements*

The applicant must comply with the performance and ATTCS reliability requirements as follows:

(a) An ATTCS failure or a combination of failures in the ATTCS during the critical time interval:

(1) Shall not prevent the insertion of the *maximum approved takeoff* thrust or power, or must be shown to be an improbable event.

(2) Shall not result in a significant loss or reduction in thrust or power, or must be shown to be an extremely improbable event.

(b) The concurrent existence of an ATTCS failure and an engine failure during the critical time interval must be shown to be extremely improbable.

(c) All applicable performance requirements of Part 25 must be met with an engine failure occurring at the most critical point during takeoff with the ATTCS system functioning.

I 25.4 *Thrust Setting*

The initial takeoff thrust or power setting on each engine at the beginning of the takeoff roll may not be less than any of the following:

(a) Ninety (90) percent of the thrust or power set by the ATTCS (the maximum takeoff thrust or power approved for the airplane under existing ambient conditions);

(b) That required to permit normal operation of all safety-related systems and equipment dependent upon engine thrust or power lever position; or

(c) That shown to be free of hazardous engine response characteristics when thrust or power is advanced from the initial takeoff thrust or power to the maximum approved takeoff thrust or power.

I 25.5 *Powerplant Controls*

(a) In addition to the requirements of § 25.1141, no single failure or malfunction, or probable combination thereof, of the ATTCS, including associated systems, may cause the failure of any powerplant function necessary for safety.

(b) The ATTCS must be designed to:

(1) Apply thrust or power on the operating engine(s), following any one engine failure during takeoff, to achieve the maximum approved takeoff thrust or power without exceeding engine operating limits;

(2) Permit manual decrease or increase in thrust or power up to the maximum takeoff thrust or power approved for the airplane under existing conditions through the use of the power lever. For airplanes equipped with limiters that automatically prevent engine operating limits from being exceeded under existing ambient conditions, other means may be used to increase the thrust or power in the event of an ATTCS failure provided the means is located on or forward of the power levers; is easily identified and operated under all operating conditions by a single action of either pilot with the hand that is normally used to actuate the power levers; and meets the requirements of § 25.777(a), (b), and (c);

(3) Provide a means to verify to the flightcrew before takeoff that the ATTCS is in a condition to operate; and

(4) Provide a means for the flightcrew to deactivate the automatic function. This means must be designed to prevent inadvertent deactivation.

I 25.6 *Powerplant Instruments*

APPENDIX 3 Current FAR Text

In addition to the requirements of § 25.1305:

(a) A means must be provided to indicate when the ATTCS is in the armed or ready condition; and

(b) If the inherent flight characteristics of the airplane do not provide adequate warning that an engine has failed, a warning system that is independent of the ATTCS must be provided to give the pilot a clear warning of any engine failure during takeoff.

APPENDIX 4 Current JAR Text

25X20 Applicability

(c) If the aeroplane is equipped with an engine control system that automatically resets the power or thrust on the operating engine(s) when any engine fails during take-off, additional requirements pertaining to aeroplane performance and limitations and the functioning and reliability of the system , contained in Appendix I, must be complied with.

APPENDIX I

I 25.1 General

(a) This Appendix specifies additional requirements and limitations for aeroplanes equipped with an engine_control system that automatically resets thrust or power on operating engine(s) when any engine fails during take-off, and for which performance credit is limited to that of paragraph 25.3(b) of this Appendix. When performance credit is not so limited, Special Conditions will apply .

(b) With the ARP system and associated systems functioning normally as designed, all applicable requirements of JAR-25, except as provided in this Appendix, must be met without requiring any action by the crew to increase thrust or power.

I 25.2 Definitions

(a) *Automatic Reserve Performance (ARP) System.* An ARP system is defined as a system which automatically resets thrust or power on the operating engines(s) when any engine fails during take-off. For the purpose of the requirements in this Appendix, the ARP system comprises all elements of equipment necessary for the control and performance of each intended function, including all devices, both mechanical and electrical, that sense engine failure, transmit signals and actuate fuel controls or power levers of the operating engines(s) to achieve scheduled thrust or power increases, the engine control system and devices which furnish cockpit information on system operation.

(b) *Critical Time Interval.* When conducting an ARP takeoff, the critical time interval is between one second before reaching V_1, and the point on the gross take-off flight path with all engines operating where, assuming a simultaneous engine and ARP system failure, the resulting flight path thereafter intersects the gross flight path, determined in accordance with JAR 25.115, at not less than 400 feet above the take-off surface. This definition is shown in the following figure:

[Illustration]

I 25.3 Performance requirements

All applicable performance requirements of JAR-25 must be met with the ARP system functioning normally as designed, except that the propulsive thrust obtained

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from each operating engine after failure of the critical engine during take-off, and the thrust at which compliance with the one-engine-inoperative climb requirements in JAR 25.121(a) and (b) is shown, must be assumed to be not greater than the lesser of–

(a) The actual propulsive thrust resulting from the initial setting of power or thrust controls with the ARP system functioning normally as designed, without requiring any action by the crew to increase thrust or power until the aeroplane has achieved a height of 400 feet above the take-off surface; or

(b) 111 percent of the propulsive thrust which would have been available at the initial setting of power or thrust controls in the event of failure of the ARP system to reset thrust power, without any action by the crew to increased thrust or power until the aeroplane has achieved a height of 400 feet above the take-off surface.

Note 1. The limitation of performance credit for ARP system operation to 111 percent of the thrust provided at the initial setting is intended to—

(i) Assure an adequate level of climb performance with all engines operating at the initial setting of power or thrust controls, and

(ii) Limit the degradation of performance in the event of a critical engine failure combined with failure of the ARP system to operate as designed

Note 2. For propeller-driven aeroplanes, propulsive thrust means the total effective propulsive force obtained from an operating engine and its propeller.

I 25.4 Reliability requirements

(See JAR 25.1309 and AMJ 25.1309)

(a) The occurrence of an ARP system failure or a combination of failures in the ARP system during the critical time interval which—

(1) Prevents the insertion of the required thrust or power, must be shown to be Improbable;

(2) Results in a significant loss or reduction in thrust or power, must be shown to be Extremely Improbable.

(a) The concurrent existence of an ARP system failure and an engine failure during the critical time interval must be shown to be Extremely Improbable.

(b) The inadvertent operation of the ARP system must be shown either to be Remote or to have no more than a minor effect.

I 25.5 Thrust or power setting

The initial setting of takeoff thrust or power controls on each engine at the beginning of the take-off roll may not be less than the lesser of:

(a) That required to permit normal operation of all safety-related systems and equipment dependent upon engine thrust or power lever position; or

(b) That shown to be free of hazardous engine response characteristics when thrust or power is increased from the initial take-off thrust or power level to the maximum approved take-off thrust or power.

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I 25.6 Powerplant controls

(a) *General*
(1) In addition to the requirements of JAR 25.1141, no single failure or malfunction, or probable combination thereof, of the ARP system, including associated systems, may cause the failure of any powerplant function necessary for safety.
(2) The ARP system must be designed to perform accurately its intended function without exceeding engine operating limits under all reasonably expected conditions.
(b) *Thrust or Power Lever Control.* The ARP system must be designed to permit manual decrease or increase in thrust or power up to the maximum thrust or power approved for use following engine failure during take-off through the use of normal thrust or power controls, except that for aeroplanes equipped with limiters that automatically prevent engine operating limits from being exceeded, other means may be used to increase thrust or power provided that the means is located in an accessible position on or close to the thrust or power levers; is easily identified and operated under all operating conditions by a single action of either pilot with the hand that is normally used to actuate the power levers.
(c) *System Control and Monitoring.* The ARP system must be designed to provide
(1) A means for checking prior to take-off that the system is in an operable condition; and
(2) A means for the flight crew to deactivate the automatic function. This means must be designed to prevent inadvertent de-activation.

I 25.7 Powerplant Instruments

(a) *System Control and Monitoring.* A means must be provided to indicate when the ARP system is in the armed or ready condition.
(b) *Engine Failure Warning.* If the inherent flight characteristics of the aeroplane do no provide adequate warning that an engine has failed, a warning system which is independent of the ARP system must be provided to give the pilot a clear warning of any engine failure during take-off.

APPENDIX 2 Proposed Existing Advisory Material Change
AC 25-13, "Reduced and Derated Takeoff Thrust (Power) Procedures"

Replace paragraph 5b with the following:

"b. Relevant speeds (V_{EF}, V_{MC}, V_1, V_R, and V_2) used for reduced thrust takeoffs are not less than those that will comply with the required airworthiness controllability criteria when using the takeoff thrust (or derated takeoff thrust, if such is the performance basis) for the ambient conditions, including the effects of an Automatic Power Reserve (APR) system."

Remove paragraph 5f(4) ("Are authorized for airplanes equipped with an ATTCS, whether operating or not, provided no performance credit is allowed for the one-engine-inoperative thrust increase.")

AC 25-7A, "Flight Test Guide for Certification of Transport Category Airplanes"

Replace "Automatic Takeoff Thrust Control System (ATTCS)" throughout paragraph 91 with "Automatic Power Reserve (APR)."

Replace paragraph 91(a)(1) with the following:

(1) Beginning in the 1970's, some manufacturers of turbojet airplanes elected to equip their airplanes with engine thrust control systems that automatically increased the thrust on the operating engine(s) when an engine failed. A similar system was later installed on some turbopropeller equipped airplanes.

Replace paragraph 91(a)(2) with the following:

(2) Takeoff performance credit was granted for APR based upon prescribed system functional and reliability requirements, and performance-related restrictions.

Remove paragraph 91(b)(4).

Replace paragraph 91(b)(5) (including (i) and (ii)) with the following:

(4) If the APR system is approved for use during reduced thrust takeoffs, the relevant takeoff speeds must meet the required controllability criteria of part 25 at the thrust level provided by operation of the APR. It must be demonstrated that the airplane has no adverse handling characteristics and the engines(s) must not exhibit adverse operating characteristics or exceed operating limits when the APR resets thrust on the operating engine(s).

(5) Takeoff with APR is not restricted when airplane performance is based on an approved derate thrust rating that has corresponding airplane and engine limitations approved for use under all weight, altitude, and temperature (WAT) conditions.